

REMARKS

Claims 1-6, 8-12 and 22-25 are pending in this application. Claim 7 is deleted.

The support for the amended claims are as follows: Claim 1 (incorporating claim 7); Claims 4, 23 and 25 (formalities amendments).

Claims 1-12 and 22-25 drawn to an organic/inorganic hydrogel have been chosen for prosecution in this application.

Claims 4, 23 and 25 have been rejected under 35 USC 112 for being indefinite. The claims have been amended to correct the indefinite language as suggested by the Examiner.

Claim 1 has been amended to incorporate claim 7. The key to obtain the organic/inorganic hybrid hydrogel is to disperse the water swelling clay mineral (B) in water (or in an aqueous solution of water and a water soluble organic solvent) into a homogeneous and finely dispersed state such that no turbidity by precipitate or aggregate of the clay mineral is observed in the dispersion as disclosed in col. 41 in U.S. Patent Application Publication No. US 2001/0049413A1.

The polymerization of the organic monomer (A') in the homogeneous dispersion of the clay mineral yields the homogeneous organic/inorganic hybrid hydrogel having the claimed mechanical properties. That is, the hydrogel exhibits superior characteristics, which are not obtained by a simple composite systems of the polymer and the solid clay mineral, such as superior transparency, reversible rubber elasticity, and the toughness to withstand deformation by compression, tension, and bending.

Claims 1-12 and 22-25 are rejected under 35 USC 102(b)/103(a) over **Murakami '163**.

A water absorbing composite disclosed by **Murakami '163** is obtained as shown, for example, in Example 1, by blending an inorganic particles such as made of kaolin having no water swelling property with a water soluble resin and organic crosslinking agent and by polymerizing the water soluble resin with an aid of the crosslinking resin. In the water absorbing material, the inorganic particles are remained as particles in the water absorbing composite and the three-dimensionally polymerized resin covers or coats surface of the inorganic particles. The water absorbing capability of this type of water absorbing composite is exhibited by the water absorbing resin coating the inorganic particle surface. It is obvious that there is no molecular bonding between the polymerized organic resin and the inorganic particles (except for a contact interlayer of the particles).

In contrast, the claimed organic/inorganic hybrid hydrogel is a homogeneous hydrogel obtained by homogeneously dispersing the inorganic clay mineral in water and by polymerizing the water soluble organic monomers dissolved in the inorganic clay mineral dispersion. As a result, a three dimensional network obtained by crosslinking of the organic polymer with the inorganic clay mineral is formed, using the dispersed fine clay mineral as crosslinking points for polymerization. This fact is definitely shown in a transmission electron micrograph shown as Fig. 3 in *Macromolecules* Vol. 35, No. 27, pp. 10162-10171, authored by K.Haraguchi et al (filed in an IDS together herewith). As shown in the transmission electron micrograph, since the inorganic clay minerals are finely dispersed and bonded to form the network, no clay mineral particle in nanometer level is observed in the micrograph.

Accordingly, the water absorbing composite disclosed in **Murakami '163** differs from the claimed homogeneously hybridized organic/inorganic hydrogel obtained by the homogeneous dispersion of the inorganic clay mineral swelled and dispersed in water and the water soluble organic resin polymerized in the presence of the clay mineral dispersion.

As explained above water absorbing composite by **Murakami '163** does not exhibit excellent mechanical properties of the claimed hydrogel such as high tensile and compressive strength, and a particular reversible rubber elasticity to be able to maintain a volume in the bending deformation.

Claims 1-7, 9-12 and 22-25 are rejected under 35 USC 102(b)/103(a) over **Libor '744**; **Kajita '547**; and **Tsipursky'528** (office action, p.5-8).

*Comparison of the claimed invention with **Libor '744** (Reference: US 4,600,744 and EP 0335653).*

Libor '744 discloses a water absorbing hydrogel obtained by mixing a water dispersion of a clay mineral and a water solution of a water soluble resin. However, it is difficult to form a homogeneous three-dimensional network crosslinked in a molecular level by only mixing (or reacting) the previously polymerized resin with the clay mineral. The reaction of the organic polymer with the clay mineral by **Libor '744** is far limited than the case of the reaction of the organic monomer with the dispersed clay mineral in the present invention. Accordingly, the hydrogel disclosed by **Libor '744** does not show excellent mechanical properties such as high

tensile strength and high compressive strength and reversible rubber elasticity obtained by the hydrogel according to the claimed invention.

Two tests, Test 1 and 2, were carried out using the same clay mineral to compare the properties between the hydrogel of the claimed invention and the properties of hydrogel by **Libor '744**. It was clearly shown in Test 2 (by the process of **Libor '744**) that the reaction between the pre-polymerized organic resin with the clay mineral is quite low, and the hydrogel obtained by mixing the water dispersion of the clay mineral and the polymer solution exhibits very low tensile strength and low compressive strength at an elongation of 100%, and the hydrogel does not show the particular properties of the claimed hydrogel.

In contrast, the hydrogel obtained in Test 1 by the formation procedure according to the claimed invention exhibits the particular optical and mechanical properties. These test results imply that the hydrogel forms a three dimensional network and the hydrogel is obtained by hybridization of the water swelling clay mineral and the water soluble organic polymer in a molecular level.

Therefore, the hydrogel disclosed by **Libor '744** does not have a three-dimensional network and differs from the hydrogel as now claimed.

Since the hydrogel in **Libor EP 0335653** was similarly obtained by mixing the water dispersion of the clay mineral and the water soluble resin, the hydrogel exhibits the same properties as those obtained by **Libor '744**. The hydrogels according to **Libor '744** differ from the hydrogel as now claimed.

*Comparison with **Kajita '547***

Kajita '547 discloses a method of forming a modified clay by impregnating a water soluble polymer into a water swellable clay to improve properties of the water swellable clay. Although the water soluble organic polymer is impregnated in the clay, the product obtained by **Kajita '547** differs from the organic/inorganic hybrid hydrogel, in which the clay mineral and the water soluble organic polymer are not crosslinked to constitute the three-dimensional network. Even if the content of the water soluble polymer is increased, the resultant hydrogel is the same as that obtained in Test 2.

Therefore, the composite by **Kajita '547** differs from the hydrogel obtained by the claimed invention.

*Comparison with **Tsipursky'528***

Tsipursky'528 discloses intercalated layered materials formed by contacting a layered material such as smectite clay mineral (phyllosilicate) with a monomer, an oligomer, and/or a polymer intercalant to absorb or intercalate between phyllosilicate platelets (col. 5, line 62 to col. 6, line 3).

The intercalate materials includes a water soluble polymer between the layers. However, the intercalate materials differ from the claimed homogeneous organic/inorganic hybrid hydrogel, in which the clay mineral and the polymer are bonded in a molecular level forming a three-dimensional network.

Accordingly, the intercalate materials disclosed by **Tsipursky'528** do not exhibit the excellent mechanical characteristics such as the high tensile strength and high compressive strength nor the reversible rubber elasticity. Therefore, the intercalate materials disclosed by **Tsipursky'528** differs from the now claimed hydrogel.

Claims 1-12 and 22-25 are rejected under 35 USC 103(a) over **Murakami '163** in view of **Sassi '211** and **Perrault '246**. As explained above, claim 1 is chemically distinct from **Murakami '163** and **Sassi '211** and **Perrault '246** fail to suggest the claimed invention in combination with **Murakami '163** which is chemically different.

*Comparison with **Sassi '211** and **Perrault '246**.*

Hydrogels disclosed in **Sassi '211** and in **Perrault '246** do not contain clay mineral and thus these hydrogels differ from the organic/inorganic hybrid hydrogel of the claimed invention.

Therefore, even when the hydrogels disclosed in the previous references are combined with those disclosed in **Sassi '211** and **Perrault '246**, the organic/inorganic hybrid hydrogel of the claimed invention is not suggested.

As described above, cited prior art references do not disclose the claimed organic/inorganic hybrid hydrogel, which has excellent mechanical characteristics, such as a tensile load at breakage of more than 0.1N, the tensile elongation at breakage of not less than 100%, and a load when the

tensile elongation is 100% of more than 0.01N, when a sample of said organic/inorganic hybrid hydrogel having a water content defined by $\{C/(A+B)\}$ of 600 to 1000 weight % and whose initial sectional area is 0.237 cm^2 is measured.

Since it is not possible by just mixing the clay mineral and the polymer to produce the hydrogel of the present invention, which has a superior transmittance and mechanical characteristics such as the reversible rubber elasticity and high tensile, compressive, and bending strengths, and the high toughness against bending, it is not logical to conclude that the organic/inorganic hybrid hydrogel of the present invention is suggested by the references.

Test results

The hydrogel of the claimed invention (Test 1) and the hydrogel according to **Libor '744** (Test 2) were prepared by respective manufacturing procedures using the same clay mineral, and the properties of both test products were compared. Bentonite (water swelling clay), which is the clay mineral in **Libor '744**, was used as the clay mineral in both Tests 1 and 2, and poly(N-isopropylacrylamide), which is the water soluble polymer used in the claimed invention, were used in both Tests 1 and 2 and respective hydrogels were prepared by respective manufacturing methods according to the present invention (Test 1) and according to **Libor '744** (Test 2).

Test 1

The organic/inorganic hybrid hydrogel was prepared by the same procedure shown in Example 1 of the present application, except bentonite (Kunipure F: a product of Kunimine

Industrial Co.) was used as the clay mineral.

The same composition as that of Example 1 of the present application was used, after obtaining a homogeneous solution by addition of the monomer, the initiator, and the catalyst to the water dispersion of the fine bentonite powder, the monomer was in-situ polymerized under presence of the fine clay mineral powder. The tensile load at breakage of 1.8 N, the elongation of a test material at breakage of 1100%, and a tensile load at an elongation of 100% of 0.10N were observed when a sample of the hydrogel having an initial cross-section of 0.237 cm² was used.

Test 2

Bentonite (Kunipure F: a product of Kunimine Industrial Co.) was used as the clay mineral and a homogeneous aqueous dispersion containing 6 wt% of the kunipure F was prepared. An water solution containing 2 wt% of the poly (N-isopropylacrylamide) was prepared by the process shown in Comparative Example 1 of the present application. According the same manufacturing process shown in Example 1 of the **Libor '744**, the water solution of poly (N-isopropylacrylamide) was added to the Kunipure F water dispersion such that the weight ratio of the clay mineral to the polymer becomes 25 to 75, and the mixture was stirred vigorously.

The product obtained by the above manufacturing process was not similar to the hydrogel now claimed. The product was not solid but a highly viscous and inhomogeneous substance, and accordingly, the product does not show any significant mechanical properties of the claimed hydrogel.

In addition, tests samples were prepared by changing the clay/polymer ratio from 80/20, 70/30, 60/40, to 50/50. Some hydrogels which do not deform by self-weight are obtained when the ratios were 80/20, 70/30, and 60/40. Although an elongation ratio of about 50% was observed when pulling a sample by hand, the samples were weak so that they cannot be tested under the mechanical test machine. These samples did not show any significant mechanical properties observed for the present hydrogel samples.

In **Libor '744**, no test samples were obtained, which can be tested by the mechanical test machine. A highly viscous sol or a mechanically weak gel was obtained in Test 2. In contrast, Test 1 yields a hydrogel having a high strength, high elasticity, and high elongation at breakage. The above test results clearly indicate that a hydrogel having superior mechanical characteristics can not be obtained by simple mixing of the clay dispersion and the pre-polymerized polymer. It is necessary to polymerize monomer of the water soluble polymer in the presence of the water swelling clay mineral homogeneously dispersed in water in order to obtain the organic/inorganic hybrid hydrogel having the excellent mechanical characteristics.

As shown above by various tests performed by the applicants, the invention as now claimed is chemically distinct and therefore not anticipated or made obvious by the cited references alone or in combination.

U.S. Patent Application Serial No. 09/864,184

In view of the aforementioned amendments and accompanying remarks, claims, as amended, are in condition for allowance, which action, at an early date, is requested.

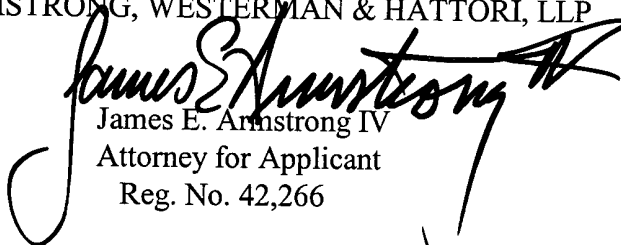
If, for any reason, it is felt that this application is not now in condition for allowance, the Examiner is requested to contact Applicants undersigned attorney at the telephone number indicated below to arrange for an interview to expedite the disposition of this case.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned "Version with markings to show changes made."

In the event that this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. Please charge any fees for such an extension of time and any other fees which may be due with respect to this paper, to Deposit Account No. 01-2340.

Respectfully submitted,

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